Creek Restoration
Swanson Hydrology + Geomorphology,

Memo dated January 16, 2009

Memo dated January 25, 2008

Report dated June 2008

Memo dated November 7, 2007

ATTACHMENT F

SWANSON HYDROLOGY + GEOMORPHOLOGY

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Project: Hillside House Development Project **Date:** August 20, 2008; Revised January 16, 2009

To: Lisa Plowman, Peikert Group Architects

From: Mitchell Swanson, President/Principal Geomorphologist

Subject: **City comments on proposed Conceptual Enhancement Plan for Arroyo Burro Creek (August 2008)**

On August 5, 2008 representatives from the Hillside House Development Project (Project) met with City of Santa Barbara (City) staff to review the Conceptual Enhancement Plan for the reach of Arroyo Burro Creek adjacent to the proposed Project. At this meeting the City asked Swanson Hydrology + Geomorphology (SH+G) to provide information regarding the differences between the extent of proposed restoration for Arroyo Burro Creek in the Veronica Meadows (VM) reach versus the Hillside House (HH) reach. At issue is "*why are the stream treatments proposed for Arroyo Burro Creek at HH so different in type and scale than those proposed for the VM reach, which includes extensive bank and streambed treatments*?"

There are three primary factors affecting the opportunities for enhancements at each site:

1. Streambed erosion/incision processes and activity;
2. Streambank stability for constructing and keying-in structures such as weirs; and
3. Constraints due to geotechnical considerations for managing liquefaction hazards.

Streambed erosion/incision

Streambed incision has largely "run its course" at HH as the channel profile is at grade with exposed bedrock near the downstream end of the project reach. In contrast, VM has active headcuts moving through the project reach and streambed incision is ongoing. Consequently, grade control is necessary for channel stability at VM, but not at HH.

The difference in streambed stability at the two locations could be the result of several factors including local geology (e.g., bedrock, landslides) and the channel's response to urbanization impacts. In the vicinity of VM several modifications have occurred within the last 50 years (1950s Alan Road / Los Positas channelization, 1960s upper State Street development/ channelization). In contrast, the land adjacent to Arroyo Burro Creek at HH has been undergoing agricultural use prior to earliest aerials (1920s) and perhaps as early as the early/mid-1800s, which would have provided more time for channel adjustments to occur.

- *Create low terrace benches replicating historic oxbows*. This would create a set of 3 or 4 arc-shaped abandoned meander cuts modeled after examples on aerial photographs, which would be constructed within the proposed buffer at elevations between 10-15 feet below the terrace grade. This option would require disposal of up to 8,000 cubic yards of fill and require slope stability mitigation (sheet pile or soil cement slurry wall) or significant modifications to the site plan.

In conclusion, there are other feasible options for enhancement of Arroyo Burro Creek at HH, but channel enhancements similar to that proposed at VM are not appropriate for the project setting.

ARROYO BURRO CREEK ENHANCEMENT PLAN

APPENDIX A

TECHNICAL MEMORANDUM WITH RESPONSE TO CITY CREEKS DIVISION COMMENTS ON CONCEPTUAL ENHANCEMENT ALTERNATIVES

NOTE: ATTACHMENTS NOT INCLUDED.
REFER TO ENGINEERING PLANS IN THE MAIN DOCUMENT.

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Project: Hillside House Development Project **Date:** January 25, 2008

To: Lisa Plowman, Peikert Group Architects

From: Kevin Fisher, Senior Restoration Ecologist; Rodney Cahill, Senior Engineer

Subject: **Revised Conceptual Enhancement Plan for Arroyo Burro Creek**

On November 12, 2007 representatives from the Hillside House Development Project (Project) met with City of Santa Barbara (City) staff to review the Conceptual Enhancement Plan for the reach of Arroyo Burro Creek adjacent to the proposed Project. At this meeting the City staff provided comments on the Enhancement Plan. This memorandum addresses comments from the City staff and presents a revised Creek Enhancement Plan for the City's consideration.

City Comments

Comment: *Explain why the grading and replanting is started mid slope rather than at the toe of the slope.*

Response: In a technical memorandum dated November 7, 2007 Swanson Hydrology + Geomorphology (SH+G) presented three conceptual enhancement alternatives for Arroyo Burro Creek and identified Alternative 3 as the preferred plan. The City staff agreed that Alternative 3 would be the preferred plan, but asked SH+G to consider the benefits of additional grading along the left channel bank. SH+G reviewed the proposed grading plan for Alternative 3 in the context of geomorphic conditions and engineering constraints at the Project site. **Attachment 1** shows a revised conceptual grading plan for the creek corridor. The revised grading plan has additional grading at the top of slope which would be beneficial for bank stability, riparian enhancement and aesthetics. This plan would grade the over-steepened upper bank throughout the length of the Project. The depth of grading would range from approximately 3 to 8 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. The revised plan would grade an additional 120 cubic yards of material from the over-steepened banks, resulting in total excavation volume of 840 cubic yards.

Revegetation at the toe of slope is only proposed in areas where giant reed or other invasive, non-native species will be removed. Mapping of these areas will be refined in the next phase of developing the Enhancement. Planting is not proposed in portions of the lower bank that are already dominated by native species.

SH+G did not analyze the scenario of grading from the toe of slope because this would preclude development of a significant portion of the Project area due to geotechnical constraints. We speculate that there could be positive and negative outcomes of grading from the toe of slope. While grading from toe would expand the riparian corridor it would have significant impacts on existing riparian habitat established at the toe and mid slopes. This type of grading could also induce new instability by forming discontinuities in channel hydraulics and sediment transport through the reach leading to undesirable or unforeseen conditions such as excessive sediment deposition and/or erosion.

Comment: *The City questioned whether slope angles of 3:1 are preferable to 2:1 for riparian enhancement in this area.*

Response: Our assessment of site conditions indicate that desirable riparian vegetation is established on slopes of 2:1 or steeper, and thus slope angle is not a critical factor for success of the Enhancement Plan. The proposed grading plan shows slopes ranging from 2:1 to 3:1, which will create a more natural appearance for the creek enhancement.

Comment: *Is there vertical instability (e.g., headcuts) in the channel downstream of the Project site that could cause significant erosion problems in the Project reach? Explain why the plan does not included methods to reduce the further incising of the creek bed.*

Response: SH+G reviewed field notes from the Project site and work conducted for the proposed Veronica Meadows project downstream of the Project area. At the downstream end of the Veronica Meadows project there is a significant grade break (6-8 foot headcut). This area has been armored with rock and grout and is considered to be stable, if maintained (Photo 1). In the Veronica Meadows project area some headcuts and vertical instability has been observed, especially in the upstream portion of the reach. It appears that these headcuts are formed by landslides depositing material in the channel and creating temporary nickpoints (Photo 2 and 3). The effects of these headcuts on channel stability are probably localized because they are likely dispersed by natural erosion processes without significant upstream migration.

For the bank stability analysis in the Project reach SH+G surveyed from the Arroyo Burro-Las Positas Creek confluence through the upstream end of the Project. No significant headcuts were observed. At the downstream end of the Project reach there is some bedrock exposed at the surface (Photo 4), suggesting some localized grade control, but the extents and influence of the bedrock are unknown. Given that the channel is incised and no significant headcuts were observed, lateral migration (i.e., widening, bank failure) is likely to be the dominant channel development process in the near term. Thus, we believe significant changes in the longitudinal profile though the Project reach are unlikely in the foreseeable future, and therefore grade control to protect from further incision is not needed at the Project site.

Comment: *How do you plan to re-establish native species were giant reed is removed?*

Response: The Project proponents recognize that removal and control of giant reed is challenging and requires maintenance for it to be effective. Eradication and control measures are likely to include multiple treatments with herbicides approved for use in aquatic settings and some manual or mechanical removal. Areas were giant reed is removed will be revegetated with native species. The Project intends to monitor and maintain the giant reed removal/revegetation areas for five years after implementation. It is anticipated that with use of various management techniques giant reed can be controlled in the Project reach during the maintenance and monitoring period. Long-term maintenance and stewardship would be coordinated with watershed-wide giant reed eradication efforts.

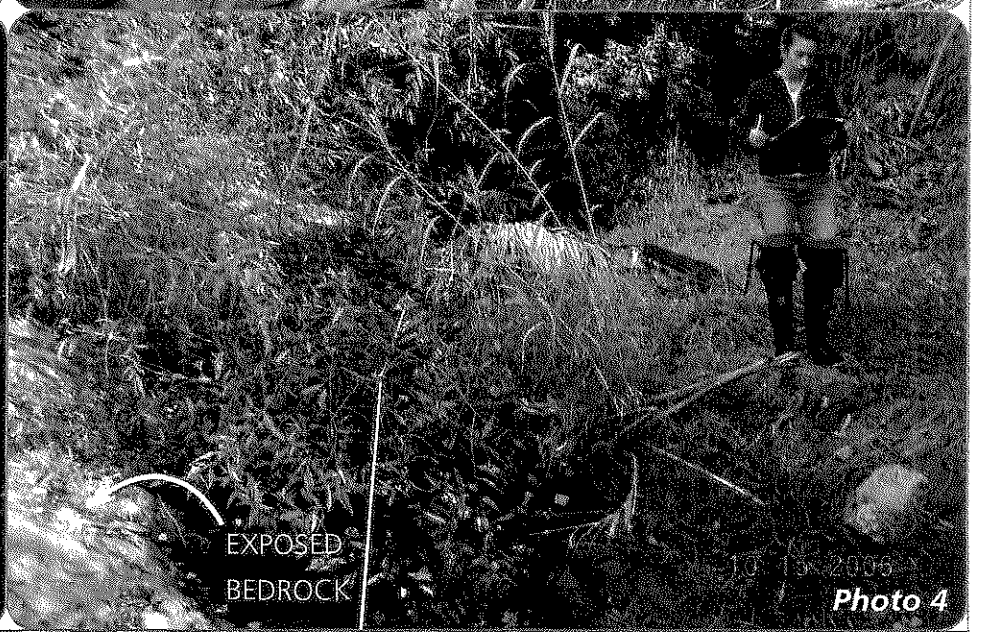

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Photo 1: Armored headcut at the downstream end of Veronica Meadows project reach.

Photo 2: Active headcut at the upstream end of the Veronica Meadows project reach.

Photo 3: Landslide contributing material to Arroyo Burro Creek forming headcuts.

Photo 4: Exposed bedrock at the downstream end of Hillside House project reach.

SWANSON HYDROLOGY + GEOMORPHOLOGY

DRAFT REPORT

Arroyo Burro Creek Enhancement Plan

Hillside House Development Project

June 2008

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1.0 INTRODUCTION

Swanson Hydrology + Geomorphology (SH+G) is working with the Housing Authority of the County of Santa Barbara, Bermant Development Company, Hillside House and the City of Santa Barbara Creeks Restoration & Water Quality Improvement Division (City Creeks Division) to design an Enhancement Plan for Arroyo Burro Creek in the vicinity of the proposed Hillside House Development Project (Project) (**Figure 1**). The objective of the Enhancement Plan is to improve bank stability and habitat conditions along the Project reach, as well as to integrate the proposed development with the creek in an environmentally-sensitive manner. Enhancement of Arroyo Burro Creek will stabilize over-steepened banks that have resulted from historical channel incision and improve the continuity of riparian habitat along the creek corridor.

1.1 REPORT ORGANIZATION

This report presents a proposed Enhancement Plan for Arroyo Burro Creek in the Project reach. Section 1 provides an introduction and review of the project setting. Section 2 presents methods and results of field investigations used to guide the development of the Enhancement Plan. Section 3 discusses design alternatives and presents the preferred plan for enhancing the creek. References are provided in Section 4.

1.2 LOCATION AND SETTING

Arroyo Burro Creek drains a moderately urbanized watershed with an area of approximately 8.75 square miles in the Santa Barbara coastal range (**Figure 1**). The upper portion of the watershed is predominantly low density residential development and orchards; the creek then passes through dense residential and commercial development between Foothill Road and Highway 101. Downstream of Highway 101, and near the Project area, the creek flows through a mix of residential and open space areas. Approximately 1.3 miles downstream of the Project site the creek discharges into a tidal lagoon, which drains into the Pacific Ocean at Arroyo Burro Beach (**Figure 1**).

2.0 SITE ASSESSMENT AND ANALYSES

The site assessment included a review of technical reports, as well as field-based investigations. The purpose of the site assessment was to identify opportunities and constraints for enhancement of Arroyo Burro Creek in the Project reach.

Technical reports and relevant information reviewed included:

- Preliminary Grading and Drainage Plans and a Drainage Report prepared by Penfield & Smith (February 28, 2006),
- Report on Seismic Hazards and Liquefaction Evaluation Report prepared by Fugro West, Inc. (April 2004),
- Geotechnical Evaluation, North Slope Area prepared by Fugro West, Inc. (June 14, 2005),
- Preliminary Geotechnical Report prepared by Fugro West, Inc. (January 2006),
- Biological Assessment prepared by Althouse and Meade Inc. (November 2005),
- DRAFT - Existing Conditions Study of Arroyo Burro, Mission, Sycamore, and Laguna Creek Watersheds prepared by Questa Engineering Corporation (August 4, 2005), and
- 30-Day Development Application Review Team (DART) Comments prepared by the City of Santa Barbara Planning Division (June 12, 2006).

Field-based assessments included a geomorphic characterization of the creek and a bank stability assessment. The results and interpretation of these investigations are discussed in the following sections.

2.1 GEOMORPHIC CHARACTERIZATION

Historical and current land use impacts in the lower watershed have contributed to confinement and constriction of the channel, resulting in changes to hydraulic and geomorphic conditions. These changes have caused Arroyo Burro Creek to cut into its bed and banks resulting in an incised channel with abandoned floodplains and terraces. The creek banks support some riparian vegetation, but they are highly unstable with a prevalence of non-native, invasive species such as giant reed (*Arundo donax*), castor bean (*Ricinus communis*) and Italian thistle (*Carduus pycnocephalus*).

The conditions observed in Arroyo Burro Creek are typical of streams responding to urbanization. Typically, channel response follows a progression of stages. The stages, as they are relevant to Arroyo Burro Creek, progress as follows (*adapted from Simon and Hupp, 1986*):

- **Stage 1:** Pre-modified channel condition consisting of a willow/alder/sycamore dominated riparian corridor present on a series of floodplain surfaces. These surfaces flooded frequently allowing deposition of fine grained material that allowed for recruitment and regeneration of the riparian community.
- **Stage 2:** Impacts from urbanization in a watershed range from direct modifications to channels (e.g. – channelization, constriction) to higher and more frequent peak flows stemming from an increase in impervious surface cover. These watershed changes lead to the impacts observed in Stage 3.

- **Stage 3:** The net result of direct impacts to the channel and modifications to the hydrologic regime is increased sediment supply from first and second order drainages and straightening and deepening of higher order channels.
- **Stage 4:** The incision described in Stage 3 eventually ends when the channel incises to a base level depth or to bedrock material that inhibits further incision. The deeply entrenched channel then begins to expend energy on the adjacent banks as it attempts to reduce the overall entrenchment and begins to build floodplain. It is at this stage that the higher order stream channels become the largest contributor to the overall sediment budget through lateral erosion of the abandoned stream terraces.
- **Stage 5:** Channel widening and aggradation mature to the point where the geometry of the active channel and floodplain match the new hydrologic conditions imposed on the channel by urbanization and land use change. Reaching Stage 5 is often a decades-long process with significant impacts to riparian and aquatic species as the transition occurs. Stage 5 often proceeds from upstream to downstream.
- **Stage 6:** Assuming hydrologic conditions have stabilized in the watershed through Best Management Practices in urban developments a new quasi equilibrium state is achieved with significant improvements to aquatic and riparian conditions.

An evaluation of Arroyo Burro Creek through the project reach suggests that despite being incised, it appears the streambed elevation has stabilized and portions are well vegetated and recovering from historical degradation. However, due to the magnitude of incision and corresponding hydraulic force during large flow events, the channel lacks stable in-channel habitat such as pools and riffles. The potential for restoration of a functioning channel bed that includes stable pool, riffle, and bar forms is limited by the presence of active landslides and debris flows along the right bank (**Figure 2**).

2.2 BANK STABILITY ANALYSIS

2.2.1 Methods

To further characterize and target enhancement opportunities, an existing conditions assessment of bank stability was conducted for the entire study reach, encompassing a total of 1,500 feet of channel along Arroyo Burro Creek. Bank stability was evaluated for the right and left banks independently, and each bank was assigned an erosion potential rating from very low to extreme. The existence of persistent landslides and landslide debris in the channel on the right bank made evaluation of parameters such as bank height difficult. Erosion potential was determined using an assessment approach adapted from Rosgen (1996). The Rosgen method is based on the assumption that the ability of a stream bank to resist erosion is primarily determined by seven components:

1. The ratio of streambank height to bankfull stage,
2. The ratio of riparian vegetation rooting depth to streambank height,
3. The degree of rooting density,
4. The composition of streambank materials,

5. Streambank angle,
6. Bank material stratigraphy and presence of soil lenses, and
7. Bank surface protection afforded by debris, vegetation, or resistant material such as boulders or bedrock.

These seven components are evaluated in the field by measuring reach length, flow distribution, erodibility, bankfull width, channel width at two times the bankfull depth (i.e. channel entrenchment), bank height, bankfull depth, sinuosity, bank angle, percent bank face protected, percent root density, rooting depth from top of bank, bank material particle size, bank material sorting, bank soil stratification, streambed material and stream gradient. Each field parameter was determined for relatively homogeneous stream and bank segments by averaging each parameter along the segment length. Bank parameters were determined for left and right banks (looking downstream) separately to determine the final index values for each stream segment. The bank erosion potential for each field segment is then determined based on the rating system developed by Rosgen (**Table 1**). Adjustments are made to the final score based on bank material and bank stratification to produce a final score for each segment. The final score is then assigned an erosion potential rating of very low, low, moderate, high, very high, or extreme.

BANK EROSION POTENTIAL

CRITERIA	VERY LOW		LOW		MODERATE		HIGH		VERY HIGH		EXTREME	
	VALUE	INDEX	VALUE	INDEX	VALUE	INDEX	VALUE	INDEX	VALUE	INDEX	VALUE	INDEX
Bank Ht/Bkf Ht	1.0-1.1	1.0-1.9	1.1-1.19	2.0-3.9	1.2-1.5	4.0-5.9	1.6-2.0	6.0-7.9	2.1-2.8	8.0-9.0	>2.8	10
Root Depth/Bank Ht	1.0-0.9	1.0-1.9	0.89-0.50	2.0-3.9	0.49-0.30	4.0-5.9	0.29-1.15	6.0-7.9	0.14-.05	8.0-9.0	<.05	10
Root Density (%)	80-100	1.0-1.9	55-79	2.0-3.9	30-54	4.0-5.9	15-29	6.0-7.9	5-14	8.0-9.0	<5.0	10
Bank Angle (Degrees)	0-20	1.0-1.9	21-60	2.0-3.9	61-80	4.0-5.9	81-90	6.0-7.9	91-119	8.0-9.0	>119	10
Surface Prot. (%)	80-100	1.0-1.9	55-79	2.0-3.9	30-54	4.0-5.9	15-29	6.0-7.9	10-15	8.0-9.0	<10	10
TOTALS												
		5-9.5		10-19.5		20-29.5		30-39.5		40-45		46-50
Numerical Adjustments												

BANK MATERIALS: BEDROCK: BANK EROSION POTENTIAL ALWAYS VERY LOW
BOULDERS: BANK EROSION POTENTIAL LOW
COBBLE: DECREASE BY ONE CATEGORY UNLESS MIXTURE OF GRAVEL/SAND IS OVER 50%, THEN NO ADJUSTMENT
GRAVEL: ADJUST VALUES UP BY 5-10 POINTS DEPENDING ON COMPOSITION OF SAND
SAND: ADJUST VALUES UP BY 10 POINTS
SILT/CLAY: NO ADJUSTMENT

STRATIFICATION: 5-10 POINTS (UPWARD) DEPENDING ON POSITION OF UNSTABLE LAYERS IN RELATION TO BANKFULL STAGE

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TABLE 1: Stream bank erosion potential rating guide from Rosgen (1996).

2.2.2 Results

Results of the bank stability survey are shown spatially on **Figure 3**. **Table 2** summarizes the bank stability ratings, and **Tables 3a and 3b** provide the bank stability statistics.

Table 2. Summary of bank erosion potential for along Arroyo Burro Creek in the Project area.

Stream Bank	Bank Erosion Potential	Linear Feet	% of Subject Reach	Stream Bank	Bank Erosion Potential	Linear Feet	% of Study Area
Right	Very Low	77	5%	*Left*	Very Low	0	0%
	Low	279	19%		Low	0	0%
	Moderate	0	0%		Moderate	0	0%
	High	553	39%		High	1,161	74%
	Very High	139	10%		Very High	187	12%
	Extreme	386	27%		Extreme	212	14%
	Total	1,434	100%		Total	1,560	100%

As shown on **Figure 3** and **Table 2** the entire left bank and more than 75% of the right bank had an erosion potential rating of 'High" or greater. This is primarily due channel incision, which is reflected in the ratio of streambank height to bankfull stage (Tables 3a and 3b). Incised channels have high erosion potential because they concentrate hydraulic force and tend to have steep banks where vegetation has difficulty establishing and/or persisting. In the Project reach banks that are protected by vegetation, with greater rooting depth/density, and/or less severe bank angle rated lower on the erodibility scale. In summary, channel incision, along with unstable geologic conditions (i.e., landslides), have yielded highly erodible streambanks. The enhancement plan presented in the following section seeks to improve the bank stability in the context of the environmental setting and proposed Project.

Table 3a. Bank stability statistics for the right bank of Arroyo Burro Creek in the Project area

Segment	Distance (ft)	Bank Height / Bankfull Height		Root Depth / Bank Height		Root Density (%)		Bank Angle		% Surface Protected		Overall Rating
		Ratio	Rating	Ratio	Rating	Percent	Rating	Degrees	Rating	Percent	Rating	
R-1*	77	6.7	Extreme	0.2	Very High	1	Extreme	60	Moderate	5	Extreme	Very High
R-2	69	2.0	High	0.5	Moderate	60	Low	50	Low	70	Low	High
R-3	66	3.4	Extreme	1.0	Very Low	70	Low	40	Low	70	Low	High
R-4	84	4.0	Extreme	0.5	Moderate	50	Moderate	60	Moderate	70	Low	High
R-5	77	2.5	Extreme	0.8	Low	80	Low	30	Low	80	Low	Moderate
R-6	164	6.3	Extreme	0.0	Extreme	2	Extreme	60	Moderate	5	Extreme	Extreme
R-7	139	7.1	Extreme	0.4	Moderate	30	High	50	Low	30	High	Very High
R-8	105	2.9	Extreme	0.8	Low	50	Moderate	30	Low	50	Moderate	High
R-9	119	2.5	Extreme	1.0	Very Low	50	Moderate	60	Moderate	70	Low	High
R-10	141	3.3	Extreme	1.0	Very Low	80	Low	30	Low	80	Low	Moderate
R-11	61	3.3	Extreme	1.0	Very Low	80	Low	30	Low	80	Low	Moderate
R-12	44	2.5	Extreme	1.0	Very Low	50	Moderate	60	Moderate	60	Low	High
R-13	58	4.2	Extreme	0.1	Very High	2	Extreme	60	Moderate	5	Extreme	Extreme
R-14	164	4.2	Extreme	0.1	Very High	2	Extreme	60	Moderate	5	Extreme	Extreme
R-15	66	3.3	Extreme	1.0	Very Low	50	Moderate	60	Moderate	60	Low	High

* Bank erodibility is adjusted to "very low" per Rosgen (1996) method because bank substrate is bedrock in this segment.

Table 3b. Bank stability statistics for the left bank of Arroyo Burro Creek in the Project area

Segment	Distance (ft)	Bank Height / Bankfull Height		Root Depth / Bank Height		Root Density (%)		Bank Angle		% Surface Protected		Overall Rating
		Ratio	Rating	Ratio	Rating	Percent	Rating	Degrees	Rating	Percent	Rating	
L-1	32	5.0	Extreme	0.5	Low	10	Very High	70	Moderate	20	High	Extreme
L-2	30	4.0	Extreme	0.8	Low	40	Moderate	75	Moderate	40	Moderate	High
L-3	70	3.4	Extreme	0.2	Very High	60	Low	75	Moderate	60	Low	Very High
L-4	115	9.0	Extreme	1.0	Very Low	60	Low	80	High	65	Low	High
L-5	184	6.7	Extreme	1.0	Very Low	50	Moderate	70	Moderate	60	Low	High
L-6	129	6.3	Extreme	0.6	Low	50	Moderate	70	Moderate	70	Low	High
L-7	180	7.1	Extreme	0.1	Very High	30	High	80	High	30	High	Extreme
L-8	126	5.0	Extreme	0.7	Low	50	Moderate	45	Low	70	Low	High
L-9	56	3.8	Extreme	0.8	Low	70	Low	60	Moderate	70	Low	High
L-10	137	6.7	Extreme	0.8	Low	60	Low	50	Low	80	Low	High
L-11	117	6.7	Extreme	0.3	Very High	30	High	70	Moderate	40	Moderate	Very High
L-12	38	5.0	Extreme	0.5	Moderate	60	Low	75	Moderate	70	Low	High
L-13	46	5.8	Extreme	0.6	Low	60	Low	70	Moderate	70	Low	High
L-14	277	3.3	Extreme	0.8	Low	40	Moderate	70	Moderate	50	Moderate	High
L-15	23	5.0	Extreme	0.7	Low	40	Moderate	50	Low	50	Moderate	High

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Tables 3a-b: Detailed results of bank stability survey.

2.3 OPPORTUNITIES AND CONSTRAINTS

The following opportunities and constraints were identified based on our review of existing information and field assessments:

Opportunities:

- Much of the left bank of the creek exhibits evidence of instability and conditions are not suitable for natural colonization of native riparian species (due to lack of fine sediment deposition and high velocities). However, there are opportunities to excavate the bank, remove exotic vegetation and plant native species to improve riparian habitat in the creek corridor.

- Where banks are steep or devoid of native riparian vegetation, restoration of a dense canopy of native riparian trees (oaks, sycamores, cottonwoods, etc.) would enhance wildlife habitat. Leaf litter and insects derived from overhanging native riparian vegetation would enhance aquatic productivity and local ecological function.

- Stabilizing the banks and planting native riparian species would reduce erosion and sediment input to the creek. This would help control future degradation of local and downstream aquatic habitat due to sedimentation.

- Lowering the angle of the streambanks along the top of bank would reduce erosion potential and improve the aesthetics of the creek.

Constraints:

- Arroyo Burro Creek flows along unstable, active landslides on the south side of the channel, which impinges on the right bank and streambed. Consequently, any construction or restoration of the channel bed, through grade control or hydraulic structures, would be subject to damage or burial. Therefore, it is not recommend that in-channel structures be included in the enhancement plan for this portion of the creek. In a worst case scenario, they could cause more damage than improvement.

- Opportunities to grade the left bank (project side) and improve channel stability are limited by the quantity of fill that would be generated and geotechnical set-backs required for safe development of the Project site due to liquefaction potential.

3.0 ENHANCEMENT PLAN

3.1 BASIS OF DESIGN

The areas to be targeted for riparian enhancement were determined by (1) the distribution of existing vegetation, (2) the bank stability analysis and (3) the "design reference top of bank" determined by the Project geotechnical engineer (Fugro West, 2006). The design reference top of bank, as shown on **Figure 2**, was used as the baseline to establish a significant buffer between the creek and development and to protect infrastructure (roads, housing units, etc.) in the event of earthquake-induced liquefaction and subsequent lateral spreading (See Fugro West, 2006 for more detail). The basis for design assumes that, in general, grading for riparian enhancement should be limited to the creek-side of the design reference top of bank to minimize safety concerns.

3.2 DESIGN DEVELOPMENT PROCESS

This section recounts the process by which the conceptual Enhancement Plan was developed. The process was initiated in October 2006 when SH+G staff attended a site visit with members of the Project Team and representatives from the City Creeks Division to review opportunities and constraints for creek enhancement. Following this meeting, field data were collected and preliminary enhancement concepts were developed. A second meeting was held in September 2007 with representatives from the City Creeks Division to review the preliminary enhancement concepts. At this meeting there was consensus that the geotechnical constraints presented by the landslides precluded grading or modification of the right bank, and it was agreed that SH+G would develop enhancement alternatives that focused on improving stability of the left bank and riparian habitat along the entire Project reach.

SH+G conducted a site visit and supplemental land survey in October 2007 to further investigate site conditions and the distribution of native and non-native vegetation. During this site visit areas that were suitable for grading were identified, and areas that should be avoided based on presence of native vegetation and stable ground conditions were mapped. The elevations where willows (*Salix* spp.) grow on the creek banks were surveyed to provide an understanding of the typical elevation range for these species at the site. The location and size of sycamore (*Platanus racemosa*) and white alder (*Alnus rhombifolia*) trees were noted, and areas of invasive, non-native vegetation such as giant reed and castor bean were delineated.

3.2.1 Alternatives

Three enhancement alternatives were developed based on the site opportunities and constraints. The alternatives are shown on **Figures 4a and 4b**. All alternatives limited grading to the creek-side of the design reference top of bank and avoided grading in established native riparian vegetation communities that exist between the toe and mid-slope on the bank. The alternatives were distinguished by the extent of grading along the mid-slope to top of bank and the preservation of existing mature native trees at the top of bank.

Alternative 1

This alternative called for grading approximately 390 feet of the upper portion of the left bank. The depth of grading would be approximately 6 to 8 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. The estimated excavation quantity for this alternative was 400 cubic yards.

The grading plan for Alternative 1 would preserve a 34" diameter at breast height (DBH) coast live oak (*Quercus agrifolia*) and a 36" DBH black walnut (*Juglans californica*) near the top of slope. Grading would be limited in the oak drip line to reduce the likelihood of damage to the tree; grading would extend into the walnut drip line to reduce near-vertical bank slopes in the vicinity of this tree.

Alternative 2

This alternative proposed grading of approximately 430 feet of the upper portion of the left bank. The depth of grading would be approximately 6 to 15 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. The estimated excavation quantity for this alternative was 900 cubic yards.

This alternative would maximize the upper bank grading between the creek and design reference top of bank. This option would result in removal of the 34" DBH oak and 36" DBH walnut trees.

Alternative 3

Alternative 3 was a hybrid of Alternatives 1 and 2. This alternative would preserve the 34" DBH oak, but remove the 36" DBH walnut. As with Alternatives 1 and 3, upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. The estimated excavation quantity for this alternative was 720 cubic yards.

3.2.2 City Creeks Division Review of Alternatives

The conceptual enhancement alternatives were presented to the City Creeks Division in a memorandum dated November 7, 2007. During a conference call the City personnel expressed that Alternative 3 would be preferred, however, they had additional comments on the proposed design. The comments were related to the extents of grading along the top of bank, slope angles and the long-term stability of the creek channel. SH+G prepared a response to these comments (see Appendix A) and modified Alternative 3 to best address the City's comments on the design.

3.3 CONCEPTUAL ENHANCEMENT PLAN

Figures 5a through 5d show the proposed conceptual Enhancement Plan for the creek corridor. In response to the City Creeks Division comments, the Enhancement Plan has been revised from the original Alternative 3 to expand the area of grading along the top of slope. This would be beneficial for bank stability, riparian enhancement and aesthetics. It is important to note that this iteration of the design extends beyond the design reference top of bank and encroaches on the geotechnical setback for the development by up to 9 feet.

The Enhancement Plan would grade the over-steepened left bank throughout the length of the Project reach, with exception of the area around the existing 34" DBH oak. The depth of grading would range from approximately 3 to 8 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. The revised plan would grade an additional 120 cubic yards of material from the over-steepened banks, resulting in total excavation volume of 840 cubic yards.

The proposed revegetation plan includes two planting zones: a lower riparian zone between the toe of slope and mid-bank, and an upper riparian/top of slope zone. Both zones include planting of container stock and application of seed. The lower riparian zone includes tree, shrub, grass and forb species adapted to mesic environments. Since there is minimal grading proposed below the mid-slope, the lower riparian zone is essentially for revegetation of areas after invasive species are removed.

The upper riparian/top of slope planting zone includes native tree, shrub, grass and forb species that are tolerant of semi-arid conditions once they are established. Walnut, sycamore and oak would be the dominant tree species and would eventually form a dense canopy along the creek and top of slope. Shrubs and herbaceous species would dominate the planting areas as the trees become established. Shrub species selected for this zone such as California buckwheat (*Eriogonum fasciculatum*), toyon (*Heteromeles arbutifolia*) and blue elderberry (*Sambucus mexicana*) provide good habitat for wildlife and are aesthetically appealing.

Several non-native, invasive species such as giant reed, castor bean and eucalyptus would be removed from the creek corridor as part of the riparian enhancement plan. Areas where non-natives are removed would be revegetated as shown on **Figure 5c**. Native trees would be planted in large container sizes (up to 24 inch boxes) in areas where eucalyptus or other mature trees species provide an overstory/canopy component to the vegetation community. Using well-established, large container size trees for revegetation would mitigate the temporary habitat and aesthetic disturbance associated with removal of mature trees.

It may require several years of maintenance to complete the invasive species eradication process. Control of giant reed is especially challenging, as this species is wide-spread in the lower Arroyo Burro watershed (Questa, 2005) and is an aggressive competitor in riparian areas. There are on-going efforts to eradicate giant reed just downstream of the Project site (pers. comm., D. Meade). Eradication efforts within the Project area should be coordinated with other giant reed control work in the creek corridor. In general, it is best to begin eradication of giant reed at the upstream extents of the infestation, but in Arroyo Burro Creek any efforts to control further spread of giant reed is considered valuable.

An irrigation system would be developed for plant establishment in the revegetation areas. The irrigation system would include short-term (1-year) overhead irrigation to establish the seed mix in the upper riparian/top of slope zone, and a temporary drip irrigation system for trees and shrubs. The drip system would need to be operated and maintained for approximately five years. Additional maintenance would include weeding and maintaining plant basins.

3.4 CONCLUSION

Implementation of the proposed Enhancement Plan would improve riparian habitat within the Project reach and potentially adjacent areas of the creek. Grading and revegetation of the over-steepened banks that are currently devoid of vegetation would potentially reduce fine-grain sediment input to the creek and improve the continuity of the riparian woodland habitat. Removal and control of non-native, invasive species would contribute to the overall resilience of the native riparian vegetation community within the Project reach and in adjacent segments of the creek corridor. Finally, revegetation on the terrace would replace the current landscaped setting dominated by exotics with a diverse native vegetation community that provides a buffer and natural transition between the creek and proposed development.

4.0 REFERENCES

Fugro West, 2006. Preliminary Geotechnical Report, Hillside House Development. January.

Rosgen. 1996. Applied River Morphology. Second Edition. Wildland Hydrology. Pagosa Springs, CO.

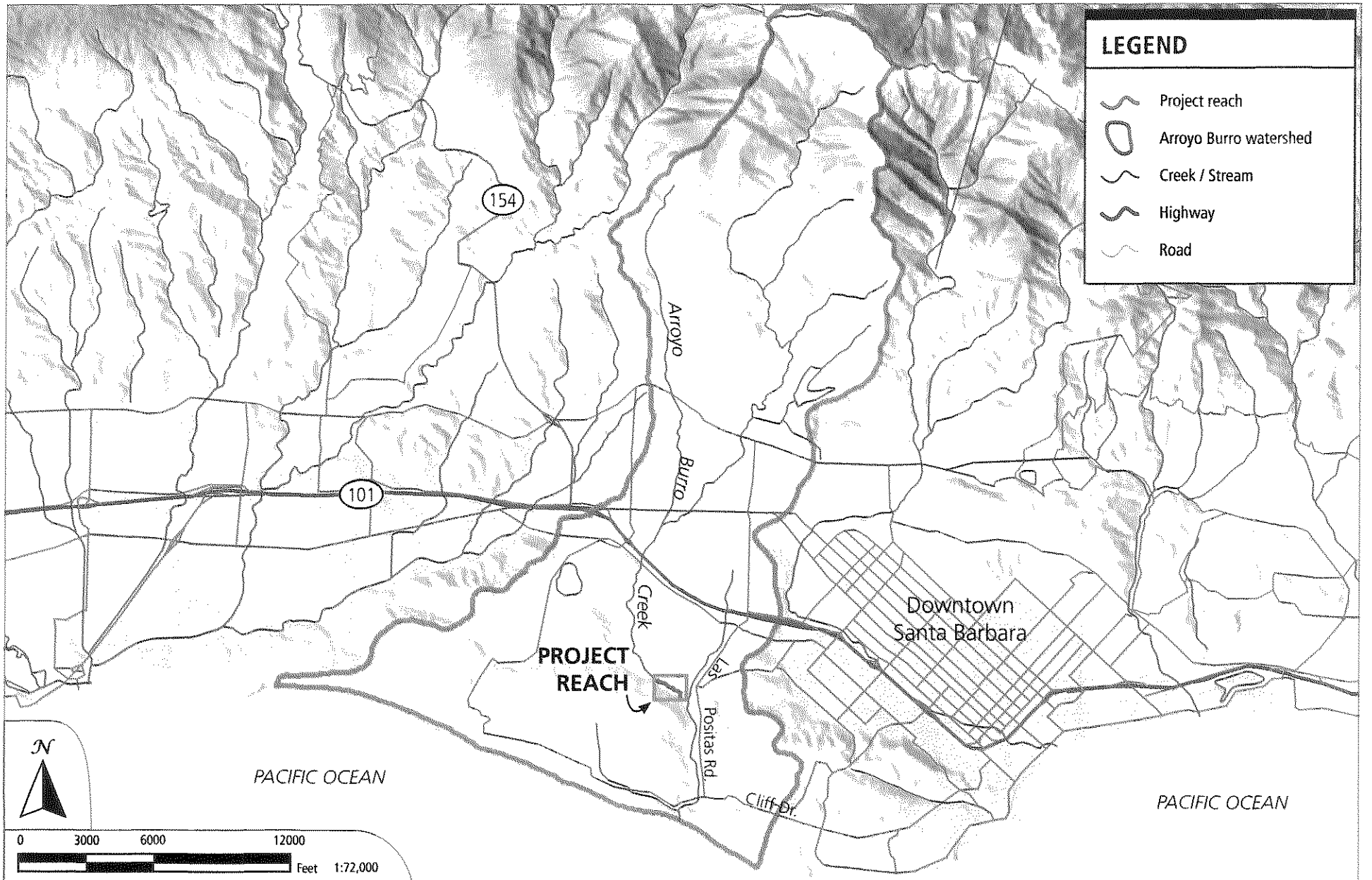
Simon, A., and Hupp, C. R., 1986, Channel evolution in modified Tennessee streams. Proceedings, Fourth Federal Interagency Sedimentation Conference, March, 1986, Las Vegas, Nevada, v. 2, p. 71-82.

Swanson Hydrology + Geomorphology (SH+G), 2006. Letter to Bermant Development Company regarding the Hillside House Development, Arroyo Burro Creek Restoration. December 22, 2006

Questa Engineering Corporation. 2005. Draft Existing Conditions Study of the Arroyo Burro, Mission, Sycamore, and Laguna Creek Watersheds. Prepared for City of Santa Barbara Creeks Restoration/Water Quality Improvement Division.

Personal Communication

Meade, Daniel. Ph.D. Althouse & Meade, Inc. Telephone conversation on November 5, 2007.



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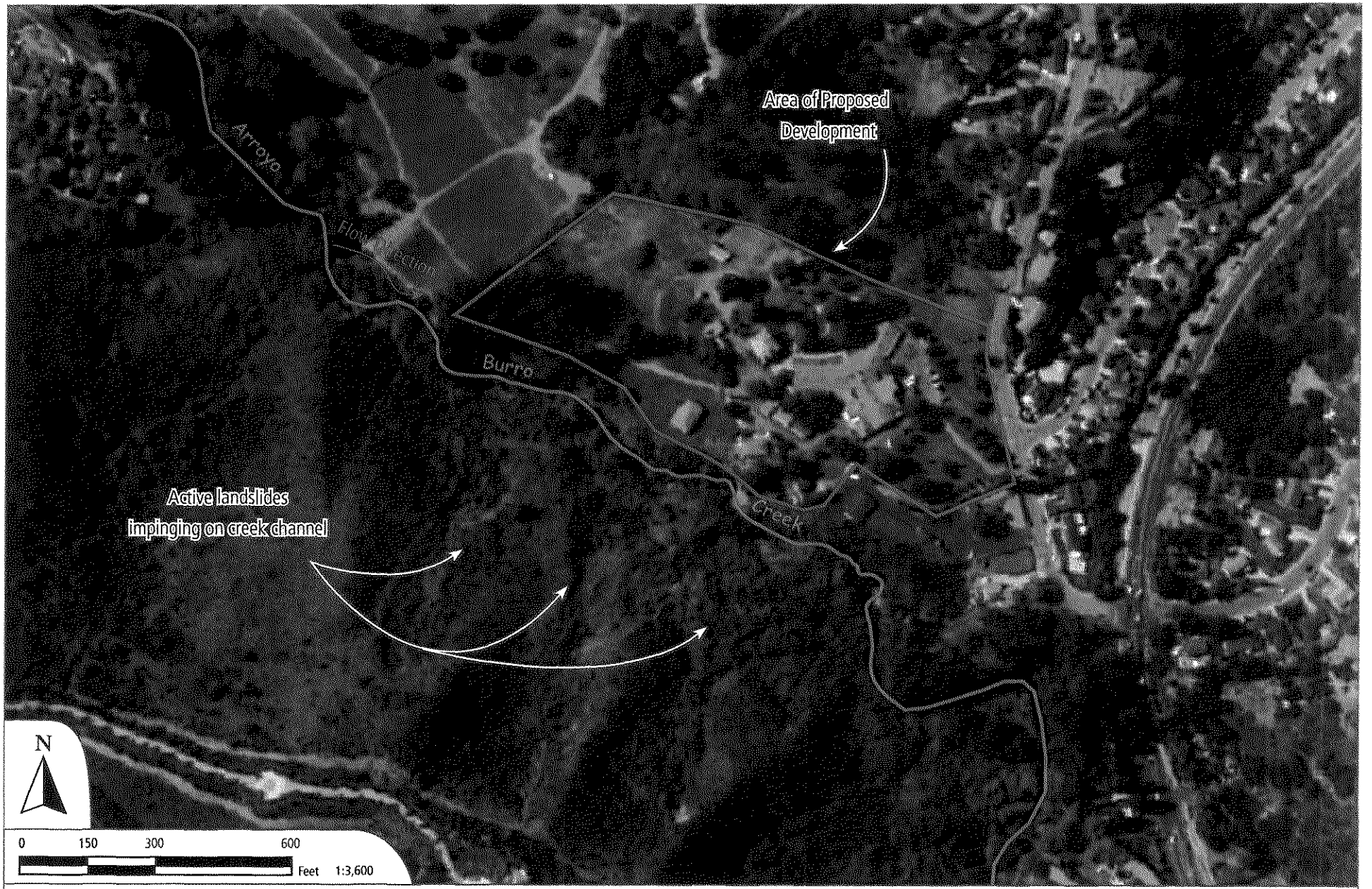
PH 831.427.0288 FX 831.427.0472

FIGURE 1: Project vicinity map.



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500 Seabright Ave, Suite 202 Santa Cruz, CA 95062
PH 831.427.0288 FX 831.427.0472

FIGURE 2: 2005 aerial photograph showing the project site and landslide conditions on Campanil Hill across Arroyo Burro Creek.

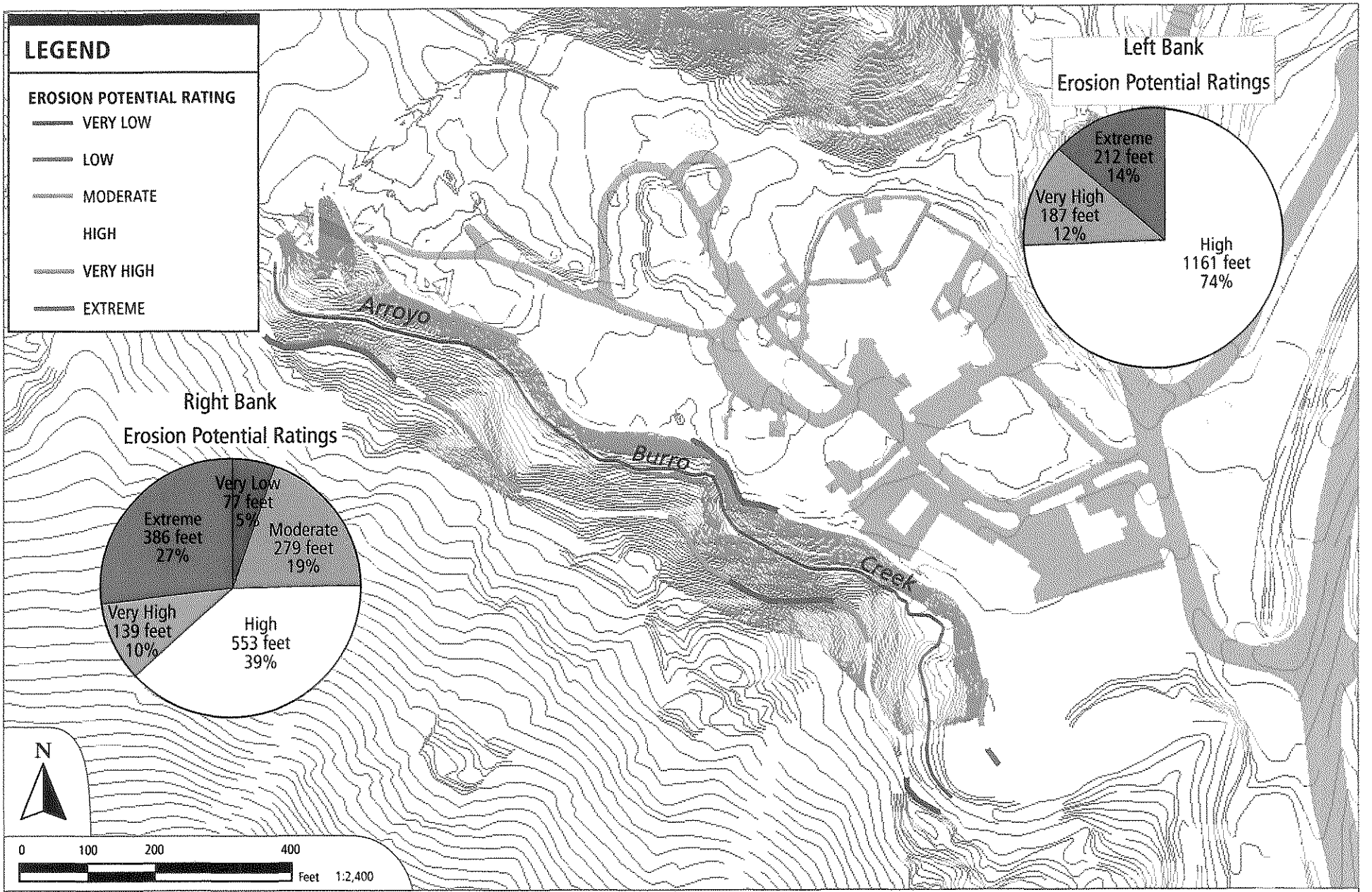

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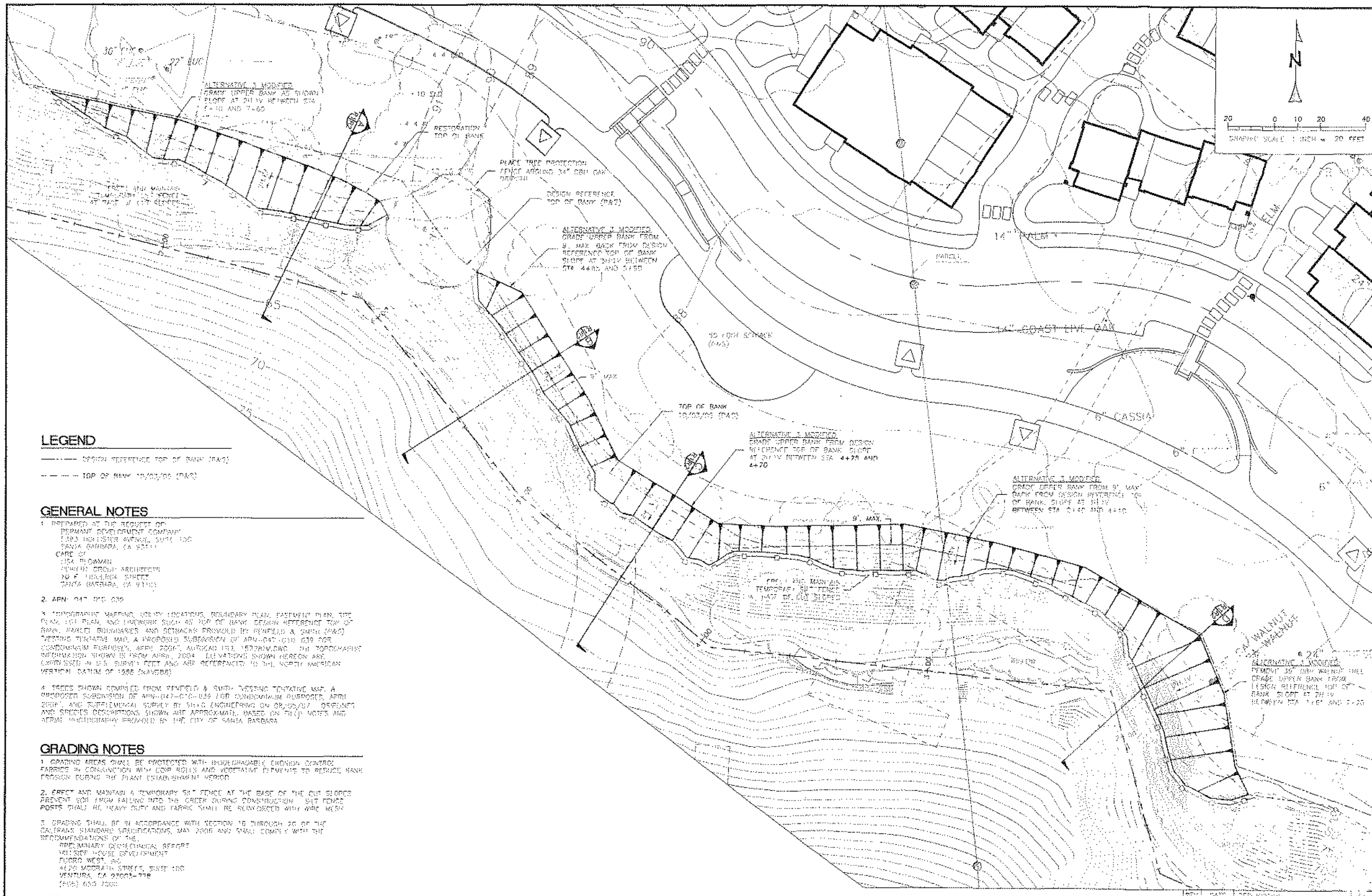
FIGURE 3: Results of the bank stability survey for the reach of Arroyo Burro Creek adjacent to the Hillside House development. Data were collected in mid-October and included: bank height, bankfull height, bank angle, percent bank face protected, root density and bank D_{50}.



LEGEND

——-—— DESIGN REFERENCE TOP OF BANK (P&S)

— — — — TOP OF BANK 10/03/05 (P&S)

GENERAL NOTES

1. PREPARED AT THE REQUEST OF:
   BERMANT DEVELOPMENT COMPANY
   5383 HOLLISTER AVENUE, SUITE 150
   SANTA BARBARA, CA 93111
   CARE OF:
   LISA PLOWMAN
   PEIKERT GROUP ARCHITECTS
   10 E. FIGUEROA STREET
   SANTA BARBARA, CA 93101

2. APN: 047-010-039

3. TOPOGRAPHIC MAPPING, UTILITY LOCATIONS, BOUNDARY PLAN, EASEMENT PLAN, SITE PLAN, LOT PLAN, AND LINEWORK SUCH AS TOP OF BANK, DESIGN REFERENCE TOP OF BANK, PARCEL BOUNDARIES AND SETBACKS PROVIDED BY PENFIELD & SMITH (P&S) "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN-047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AUTOCAD FILE 15728MV.DWG. THE TOPOGRAPHIC INFORMATION SHOWN IS FROM APRIL, 2004. ELEVATIONS SHOWN HEREON ARE EXPRESSED IN U.S. SURVEY FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

4. TREES SHOWN COMPILED FROM PENFIELD & SMITH "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN-047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AND SUPPLEMENTAL SURVEY BY SH+G ENGINEERING ON 08/05/07. DRIPLINES AND SPECIES DESCRIPTIONS SHOWN ARE APPROXIMATE, BASED ON FIELD NOTES AND AERIAL PHOTOGRAPHY PROVIDED BY THE CITY OF SANTA BARBARA.

GRADING NOTES

1. GRADING AREAS SHALL BE PROTECTED WITH BIODEGRADABLE EROSION CONTROL FABRICS IN CONJUNCTION WITH COIR ROLLS AND VEGETATIVE ELEMENTS TO REDUCE BANK EROSION DURING THE PLANT ESTABLISHMENT PERIOD.

2. ERECT AND MAINTAIN A TEMPORARY SILT FENCE AT THE BASE OF THE CUT SLOPES. PREVENT SOIL FROM FALLING INTO THE CREEK DURING CONSTRUCTION. SILT FENCE POSTS SHALL BE HEAVY DUTY AND FABRIC SHALL BE REINFORCED WITH WIRE MESH.

3. GRADING SHALL BE IN ACCORDANCE WITH SECTION 15 THROUGH 20 OF THE CALTRANS STANDARD SPECIFICATIONS, MAY 2006 AND SHALL COMPLY WITH THE RECOMMENDATIONS OF THE:
   PRELIMINARY GEOTECHNICAL REPORT
   HILLSIDE HOUSE DEVELOPMENT
   FUGRO WEST, INC.
   4820 MCGRATH STREET, SUITE 100
   VENTURA, CA 93003-778
   (805) 650-7000

4. TRANSITION SLOPES SMOOTHLY FROM 2:1H:1V, UNLESS NOTED OTHERWISE.

5. PLACE TREE PROTECTION AROUND THE DRIPLINE OF THE 34" DBH OAK TO BE PRESERVED AND AVOID DISTURBANCE AND ACCESS WITHIN THE DRIPLINE.

CONCEPTUAL GRADING PLAN
SCALE: 1"=20'

GRAPHIC SCALE: 1 INCH = 20 FEET

NOT FOR CONSTRUCTION

PREPARED AT THE REQUEST OF:
BERMANT DEVELOPMENT COMPANY
5383 HOLLISTER AVENUE, SUITE 150
SANTA BARBARA, CA

CONCEPTUAL GRADING PLAN

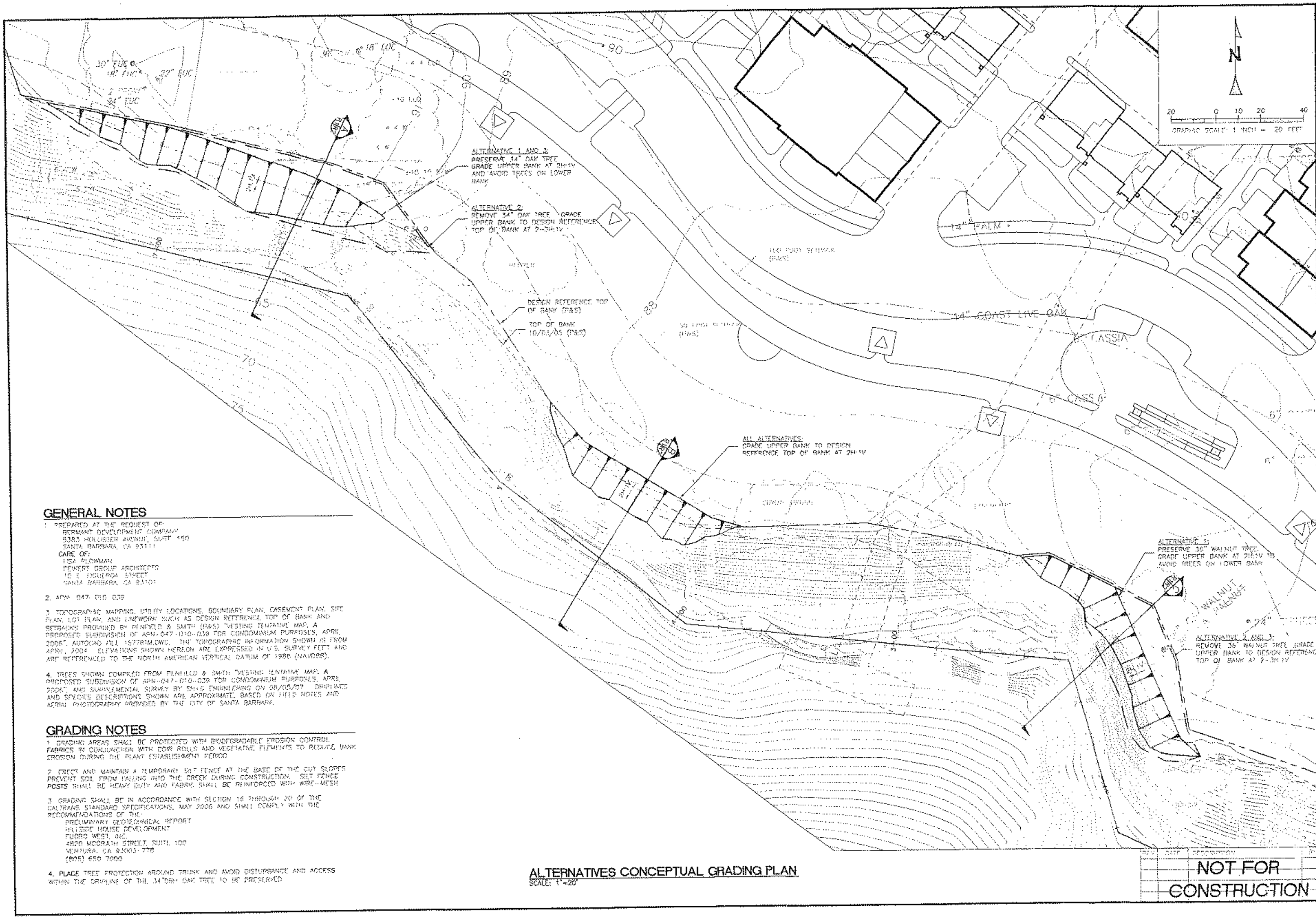
ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

DESIGNED BY: R.T.C.
DRAWN BY: R.T.C.
CHECKED BY: K.F.
DATE: **/08/07
JOB NO. 06-538

BAR IS ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES FOR REDUCED PLOTS

SH+G ENGINEERING
500 SEABRIGHT AVE., SUITE 202
SANTA CRUZ, CA 95062
(831) 427-0288

FIG. 5A



GENERAL NOTES

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   BERMANT DEVELOPMENT COMPANY
   5383 HOLLISTER AVENUE, SUITE 150
   SANTA BARBARA, CA 93111
   CARE OF:
   LISA PLOWMAN
   PEIKERT GROUP ARCHITECTS
   10 E. FIGUEROA STREET
   SANTA BARBARA, CA 93101

2. APN: 047-010-039

3. TOPOGRAPHIC MAPPING, UTILITY LOCATIONS, BOUNDARY PLAN, EASEMENT PLAN, SITE PLAN, LOT PLAN, AND LINEWORK SUCH AS DESIGN REFERENCE TOP OF BANK AND SETBACKS PROVIDED BY PENFIELD & SMITH (P&S) "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN-047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AUTOCAD FILE 15778TM.DWG. THE TOPOGRAPHIC INFORMATION SHOWN IS FROM APRIL, 2004. ELEVATIONS SHOWN HEREON ARE EXPRESSED IN U.S. SURVEY FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

4. TREES SHOWN COMPILED FROM PENFIELD & SMITH "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN-047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AND SUPPLEMENTAL SURVEY BY SH+G ENGINEERING ON 08/05/07. DRIPLINES AND SPECIES DESCRIPTIONS SHOWN ARE APPROXIMATE, BASED ON FIELD NOTES AND AERIAL PHOTOGRAPHY PROVIDED BY THE CITY OF SANTA BARBARA.

GRADING NOTES

1. GRADING AREAS SHALL BE PROTECTED WITH BIODEGRADABLE EROSION CONTROL FABRICS IN CONJUNCTION WITH COIR ROLLS AND VEGETATIVE ELEMENTS TO REDUCE BANK EROSION DURING THE PLANT ESTABLISHMENT PERIOD.

2. ERECT AND MAINTAIN A TEMPORARY SILT FENCE AT THE BASE OF THE CUT SLOPES PREVENT SOIL FROM FALLING INTO THE CREEK DURING CONSTRUCTION. SILT FENCE POSTS SHALL BE HEAVY DUTY AND FABRIC SHALL BE REINFORCED WITH WIRE-MESH.

3. GRADING SHALL BE IN ACCORDANCE WITH SECTION 16 THROUGH 20 OF THE CALTRANS STANDARD SPECIFICATIONS, MAY 2006 AND SHALL COMPLY WITH THE RECOMMENDATIONS OF THE:
   PRELIMINARY GEOTECHNICAL REPORT
   HILLSIDE HOUSE DEVELOPMENT
   FUGRO WEST, INC.
   4820 MCGRATH STREET, SUITE 100
   VENTURA, CA 93003-778
   (805) 650-7000

4. PLACE TREE PROTECTION AROUND TRUNK AND AVOID DISTURBANCE AND ACCESS WITHIN THE DRIPLINE OF THE 34"DBH OAK TREE TO BE PRESERVED.

ALTERNATIVES CONCEPTUAL GRADING PLAN
SCALE: 1"=20'

NOT FOR CONSTRUCTION

ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

ALTERNATIVES CONCEPTUAL GRADING PLAN

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BERMANT DEVELOPMENT COMPANY
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SANTA BARBARA, CA

SH+G ENGINEERING
500 SEABRIGHT AVE., SUITE 202
SANTA CRUZ, CA 95062
(831) 427-0288

DESIGNED BY: P.T.C.
DRAWN BY: P.T.C.
CHECKED BY: K.T.
DATE: 11/08/07
JOB NO: 06-538

BAR IS ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES FOR REDUCED PLOTS

FIG. 4A

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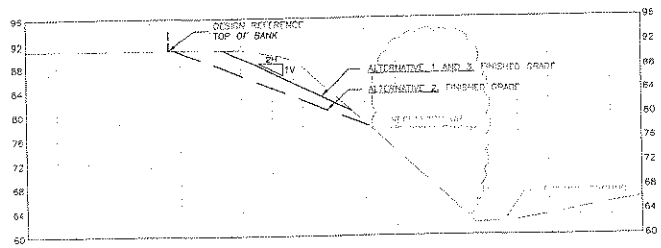

CROSS SECTION (A / R1R2)
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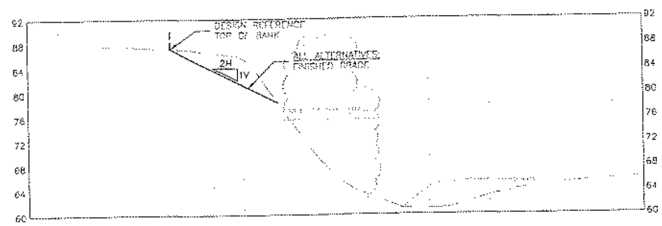

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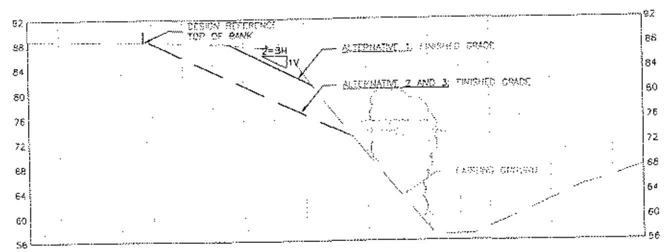

CROSS SECTION (C / R1R2)
SCALE: 1"=10'

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SANTA CRUZ, CA 95062
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5383 HOLLISTER AVENUE, SUITE 150
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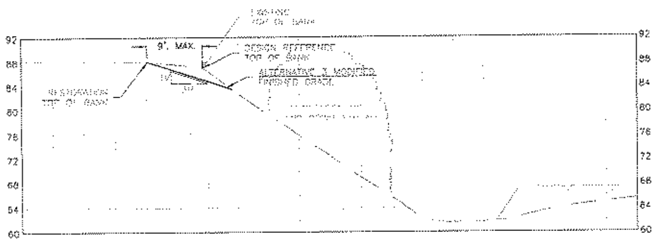
ALTERNATIVES CROSS SECTIONS

ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

DATE: 11/08/07

FIG. 4B



CROSS SECTION (B)
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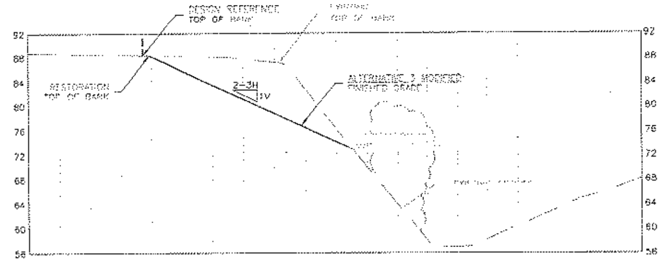

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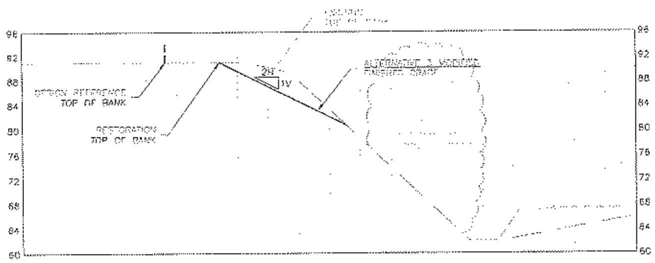

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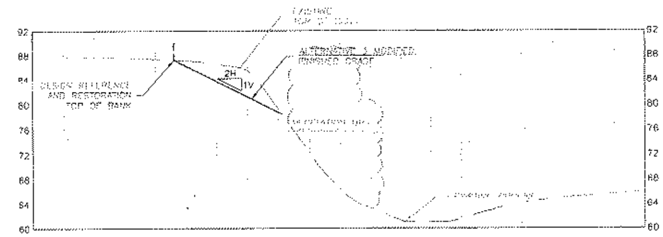

CROSS SECTION (C)
SCALE: 1"=10'

REV	DATE	DESCRIPTION	BY
		NOT FOR CONSTRUCTION	

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(831)-477-0288

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5383 HOLLISTER AVENUE, SUITE 150
SANTA BARBARA, CA

CROSS SECTIONS

ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

DESIGNED BY: R.T.C.
DRAWN BY: R.T.C.
CHECKED BY: K.T.
DATE: 11/08/07
JOB NO.: 06-538

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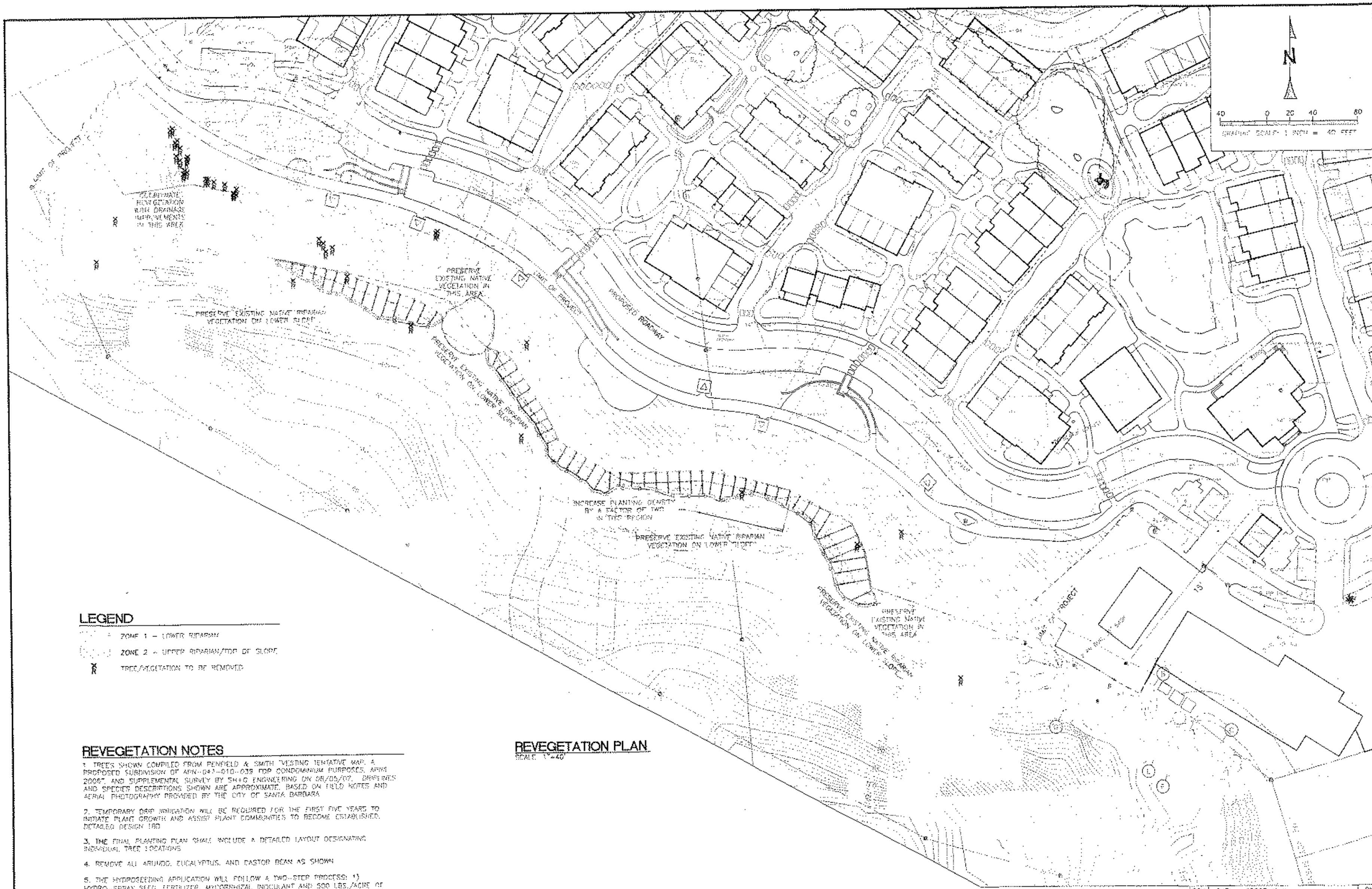
FIG. 5B

R:\LAND PROJECTS\06-538_HILLSIDE_HOUSE\dwg\06-538 Conceptual Enhancement Plan.dwg 6/5/2008 4:38:37 PM PDT



LEGEND

- ZONE 1 – LOWER RIPARIAN
- ZONE 2 – UPPER RIPARIAN/TOP OF SLOPE
- TREE/VEGETATION TO BE REMOVED

REVEGETATION PLAN

SCALE: 1"=40'

REVEGETATION NOTES

1. TREES SHOWN COMPILED FROM PENFIELD & SMITH "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN-047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AND SUPPLEMENTAL SURVEY BY SH+G ENGINEERING ON 08/05/07. DRIPLINES AND SPECIES DESCRIPTIONS SHOWN ARE APPROXIMATE, BASED ON FIELD NOTES AND AERIAL PHOTOGRAPHY PROVIDED BY THE CITY OF SANTA BARBARA.

2. TEMPORARY DRIP IRRIGATION WILL BE REQUIRED FOR THE FIRST FIVE YEARS TO INITIATE PLANT GROWTH AND ASSIST PLANT COMMUNITIES TO BECOME ESTABLISHED. DETAILED DESIGN TBD

3. THE FINAL PLANTING PLAN SHALL INCLUDE A DETAILED LAYOUT DESIGNATING INDIVIDUAL TREE LOCATIONS.

4. REMOVE ALL ARUNDO, EUCALYPTUS, AND CASTOR BEAN AS SHOWN

5. THE HYDROSEEDING APPLICATION WILL FOLLOW A TWO-STEP PROCESS: 1) HYDRO-SPRAY SEED, FERTILIZER, MYCORRHIZAL INOCULANT AND 500 LBS./ACRE OF HYDRAULIC STRAW AND TACK MULCH AND 2) APPLY 2500 LBS./ACRE HYDRAULIC STRAW AND TACK MULCH.

SH+G ENGINEERING
500 SEABRIGHT AVE., SUITE 202
SANTA CRUZ, CA 95062
(831) 427-0288
A Division of Seaward Hydrology • Geomorphology

PREPARED AT THE REQUEST OF:
BERMANT DEVELOPMENT COMPANY
5383 HOLLISTER AVENUE, SUITE 150
SANTA BARBARA, CA

REVEGETATION PLAN

ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

DESIGNED BY: K.F.
DRAWN BY: P.T.C.
CHECKED BY:
DATE: 11/08/07
JOB NO: 06-538

BAR IS ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES FOR REDUCED PLOTS

REV.	DATE	DESCRIPTION	BY

NOT FOR CONSTRUCTION

FIG. 5C

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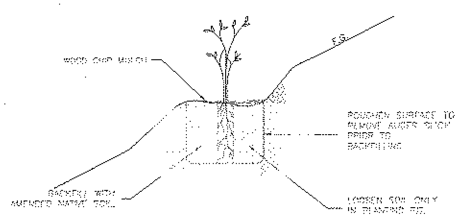
CONTAINER STOCK AND CUTTINGS

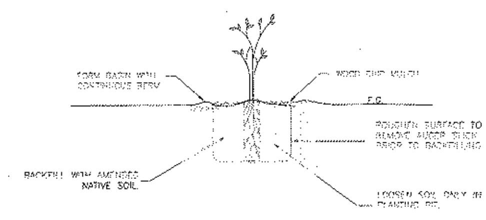
Zone	Botanical name	Common Name	Propogation Method	Sizes	Spacing	Growth Form
1-Lower Riparian	*Populus balsamifera ssp. trichocarpa*	black cottonwood	Container	5 Gal	Average 12 ft O.C.	tree
	Alnus rhombifolia	alder	Container	1 Gal	Average 8 ft O.C.	tree
	Baccharis salicifolia	mule fat	Container	1 Gal		shrub
	Salix spp.	willow species	Cuttings	4 ft length, 0.75 to 3 inch diameter	Average 5 ft O.C.	tree/shrub
	Leymus triticoides	creeping wildrye	Container	TreeBand	Average 5 ft O.C.	grass
2-Upper Riparian/Top of Slope	*Juglans californica*	black walnut	Container	5 Gal, 15 Gal, 24" Box	Average 12 ft O.C.	tree
	Platanus racemosa	sycamore	Container	5 Gal, 15 Gal, 24" Box		tree
	Sambucus mexicana	blue elderberry	Container	5 Gal		tree/shrub
	Quercus agrifolia	coast live oak	Container	5 Gal, 15 Gal, 24" Box		tree
	Eriogonum fasciculatum	California buckwheat	Container	1 Gal	Average 5 ft O.C.	shrub
	Heteromeles arbutifolia	toyon	Container	1 Gal		shrub
	Lonicera hispidula	hairy honesuckle	Container	1 Gal		shrub
	Mimulus aurantiacus	monkey flower	Container	1 Gal		shrub
	Myrica californica	California wax myrtle	Container	1 Gal		shrub
	Rhamnus californicus	coffeeberry	Container	1 Gal		shrub
	Salvia mellifera	black sage	Container	1 Gal		shrub

SEED MIXES

Zone	Botanical name	Common Name	Propogation Method	lbs/acre	Spacing/ Remarks	Growth Form
1-Lower Riparian	Achillea millefolium	yarrow	Broadcast seed	2	NA	forb
	Artemisia douglasiana	mugwort	Broadcast seed	4	NA	forb
	Collinsia heterophylla	Chinese houses	Broadcast seed	2	NA	forb
	Elymus glaucus	blue wildrye	Broadcast seed	8	NA	grass
	Hordeum brachyantherum	California barley	Broadcast seed	8	NA	grass
	Lasthenia glabrata	goldfields	Broadcast seed	2	NA	fob
	Leymus triticoides	creeping wild rye	Broadcast seed	8	NA	grass
	Mimulus gutattus	seep monkeyflower	Broadcast seed	2	NA	forb
	Trifolium obtusiflorum	creek clover	Broadcast seed	2	NA	forb
	Vulpia microstachys	vulpia	Broadcast seed	8	NA	grass
2-Upper Riparian/Top of Slope	Artemisia douglasiana	mugwort	Broadcast seed	4	NA	forb
	Elymus glaucus	blue wildrye	Broadcast seed	8	NA	grass
	Eschscholzia californica	California poppy	Broadcast seed	2	NA	forb
	Lotus scoparius	deerweed	Broadcast seed	4	NA	forb
	Lupinus succulentus	arroyo lupine	Broadcast seed	2	NA	forb
	Nassella pulchra	Purple needle-grass	Broadcast seed	8	NA	grass
	Scrophularia californica	bee balm	Broadcast seed	2	NA	forb
	Sisyrinchium bellium	blue eyed grass	Broadcast seed	2	NA	forb
	Vulpia microstachys	vulpia	Broadcast seed	8	NA	grass



CONTAINER PLANTING ON SLOPES (1 / R4|R4)
SCALE: N.T.S.



CONTAINER PLANTING (2 / R4|R4)
SCALE: N.T.S.

REV.	DATE	DESCRIPTION	BY

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SANTA BARBARA, CA

PLANTING PALETTE AND PLANTING DETAILS

ARROYO BURRO CREEK ENHANCEMENT PLAN
HILLSIDE HOUSE DEVELOPMENT PROJECT

DESIGNED BY: K.F.
DRAWN BY: R.T.C.
CHECKED BY:
DATE: 11/08/07
JOB NO.: 06-538

BAR IS ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES FOR REDUCED PLOTS
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FIG. 5D

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SWANSON HYDROLOGY + GEOMORPHOLOGY

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A California Corporation

500 Seabright Ave, Suite 202 Santa Cruz, CA 95062

www.swansonh2o.com

Project:	Hillside House Development Project	Date:	November 7, 2007
To:	Lisa Plowman, Peikert Group Architects		
From:	Kevin Fisher, Senior Restoration Ecologist; Rodney Cahill, Senior Engineer		
Subject:	Conceptual Enhancement Plan for Arroyo Burro Creek		

This Technical Memorandum describes a Conceptual Enhancement Plan for the reach of Arroyo Burro Creek adjacent to the proposed Hillside House Development Project (Project). Enhancement opportunities for Arroyo Burro Creek in the Project reach were identified by Swanson Hydrology + Geomorphology (SH+G) in a letter report dated December 22, 2006 (SH+G, 2006). These opportunities include grading portions of the over-steepened upper banks, removing exotic vegetation and planting native species along the riparian corridor. Improving bank stability by grading and planting native riparian species would reduce the potential for bank erosion and subsequent sediment input to the creek. This Conceptual Enhancement Plan is designed to meet these objectives within the context of existing creek morphology, riparian habitat conditions and the proposed development plan.

Basis of Design

The areas available for riparian enhancement were determined by (1) the distribution of existing vegetation, (2) bank stability analysis (SH+G, 2006) and (3) the design reference top of bank determined by the Project geotechnical engineer (Fugro West, 2006). A site visit and supplemental land survey were completed in October 2007 to refine our understanding of site conditions and investigate the distribution of native and non-native vegetation. During this site visit areas that are suitable for grading were identified, and areas that should be avoided based on presence of native vegetation and stable ground conditions were mapped. We located a previously unmapped 34" diameter at breast height (DBH) coast live oak (*Quercus agrifolia*) and recorded data describing the canopy drip lines of this oak and a 36" DBH walnut (*Juglans californica)* located at the top of bank. The elevations where willows (*Salix* spp.) grow on the creek banks were surveyed to provide an understanding of the typical elevation range for these species at the site. The location and size of sycamore (*Platanus racemosa*) and white alder (*Alnus rhombifolia*) trees were noted, and areas of invasive, non-native vegetation such as giant reed (*Arundo donax*) and castor bean (*Ricinus communis*) were delineated.

Enhancement Alternatives

Three enhancement alternatives were developed based on the site opportunities and constraints. The alternatives are shown in Attachment A (Sheets R1-R3). The enhancement alternatives incorporate upper bank grading, native plant revegetation and invasive species removal. All alternatives limit grading to the creek side of the design reference top of bank and avoid grading in established native riparian vegetation communities that exist between the toe and mid-slope on the bank (i.e., elevation 70 to 78 feet). The alternatives are distinguished by the extent of grading and the preservation of existing mature native trees at the top of bank.

ALTERNATIVE 1

This alternative includes grading approximately 390 feet of the upper portion of the north bank of Arroyo Burro Creek. The depth of grading is approximately 6 to 8 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. Slope angles may vary (typically shallower) at transitions to undisturbed areas at the top of bank and mid-slope. The estimated excavation quantity for this alternative is 400 cubic yards.

The grading plan for Alternative 1 preserves the 34" DBH oak and 36" DBH walnut near the top of slope. Grading is limited in the oak drip line to reduce the likelihood of damage to the tree. Grading is extended into the walnut drip line to reduce near-vertical bank slopes in the vicinity of this tree. It may not be feasible to completely protect the existing walnut given the extreme bank instability near the tree and its proximity to the top of bank. Surface protection such as biodegradable erosion control fabric and coir rolls may be necessary to stabilize slope surfaces during the plant establishment period.

ALTERNATIVE 2

This alternative includes grading approximately 430 feet the upper portion of the north bank of Arroyo Burro Creek. The depth of grading is approximately 6 to 15 feet below the current top of bank. Upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. Slope angles may vary (typically shallower) at transitions to undisturbed areas at the top of bank and mid-slope. The estimated excavation quantity for this alternative is 900 cubic yards.

This alternative maximizes upper bank grading between the creek and design reference top of bank. This option would results in removal of the 34" DBH oak and 36" DBH walnut trees. Surface protection such as biodegradable erosion control fabric and coir rolls may be necessary to stabilize slope surfaces during the plant establishment period.

ALTERNATIVE 3

Alternative 3 is a hybrid of Alternatives 1 and 2. This alternative would preserve the 34" DBH oak, but remove the 36" DBH walnut (see Sheets R1 and R2 in Attachment A). As with Alternatives 1 and 3, upper bank slopes that are currently near vertical would be graded to range from 2H:1V to 3H:1V. Slope angles may vary (typically shallower) at transitions to undisturbed areas at the top of bank and mid-slope. The estimated excavation quantity for this alternative is 720 cubic yards.

Revegetation and Invasive Species Removal Plan

The proposed revegetation plan includes 2 planting zones: a lower riparian zone between the toe of slope and mid-bank, and an upper riparian/top of slope zone. Both zones include planting of container stock and application of seed. The lower riparian zone includes tree, shrub, grass and forb species adapted to mesic environments. Since there is minimal grading proposed below the mid-slope, the lower riparian zone is essentially for revegetation of areas after invasive species are removed.

The upper riparian/top of slope planting zone includes native tree, shrub, grass and forb species that are tolerant of semi-arid conditions once they are established. Walnut, sycamore and oak would be the dominant tree species and would eventually form a dense canopy along the creek and top of slope. Shrubs and herbaceous species would dominate the planting areas as the trees become established. Shrub species selected for this zone such as California buckwheat (*Eriogonum fasciculatum*), toyon (*Heteromeles arbutifolia*) and blue elderberry (*Sambucus mexicana*) provide good habitat for wildlife and are aesthetically appealing.

Several non-native, invasive species such as giant reed, castor bean and eucalyptus will be removed from the creek corridor as part of the riparian enhancement plan. Areas where non-natives are removed will be revegetated as shown in the Conceptual Plan. It may require several years of maintenance to complete the invasive species eradication process. Control of giant reed is especially challenging, as this species is wide-spread in the lower Arroyo Burro watershed (Questa, 2005) and is an aggressive competitor in riparian areas. There are on-going efforts to eradicate giant reed just downstream of the Project site (pers. comm., D. Meade). Eradication efforts within the Project area should be coordinated with other giant reed control work in the creek corridor. In general, it is best to begin eradication of giant reed at the upstream extents of the infestation, but in Arroyo Burro Creek any efforts to control further spread of giant reed is considered valuable.

An irrigation system will be developed for plant establishment in the revegetation areas. The irrigation system will include short-term (1-year) overhead irrigation to establish the seed mix in the upper riparian/top of slope zone, and a temporary drip irrigation system for trees and shrubs. The drip system would need to be operated

and maintained for approximately five years. Additional maintenance would include weeding and maintaining plant basins.

Recommendations and Benefits

We recommend implementing Alternative 3. This alternative provides an appropriate balance between protection of existing mature trees, erosion control and native species revegetation. The walnut tree that would be removed in this alternative is on the edge of a near vertical bank and its long-term viability if preserved is uncertain. The revegetation plan would include a minimum of 10:1 in-kind replacement for removal of this tree, and other native trees removed by the Project.

Implementation of the Conceptual Enhancement Plan would improve riparian habitat within the Project reach and potentially adjacent areas of the creek. Grading and revegetation of the over-steepened banks that are currently devoid of vegetation will reduce fine-grain sediment input to the creek (by up to 720 cubic yards) and improve the continuity of the riparian woodland habitat. Leaf litter and insects derived from riparian vegetation will enhance aquatic productivity and local ecological function. Removal of non-native, invasive species will contribute to the overall resilience of the native riparian vegetation community within the Project reach and in adjacent segments of the creek corridor. Finally, revegetation on the terrace will replace the current landscaped setting dominated by exotics with a diverse native vegetation community that provides a buffer and natural transition between the creek and proposed development.

REFERENCES

Fugro West, 2006. Preliminary Geotechnical Report, Hillside House Development. January 11, 2006

Swanson Hydrology + Geomorphology (SH+G), 2006. Letter to Bermant Development Company regarding the Hillside House Development, Arroyo Burro Creek Restoration. December 22, 2006

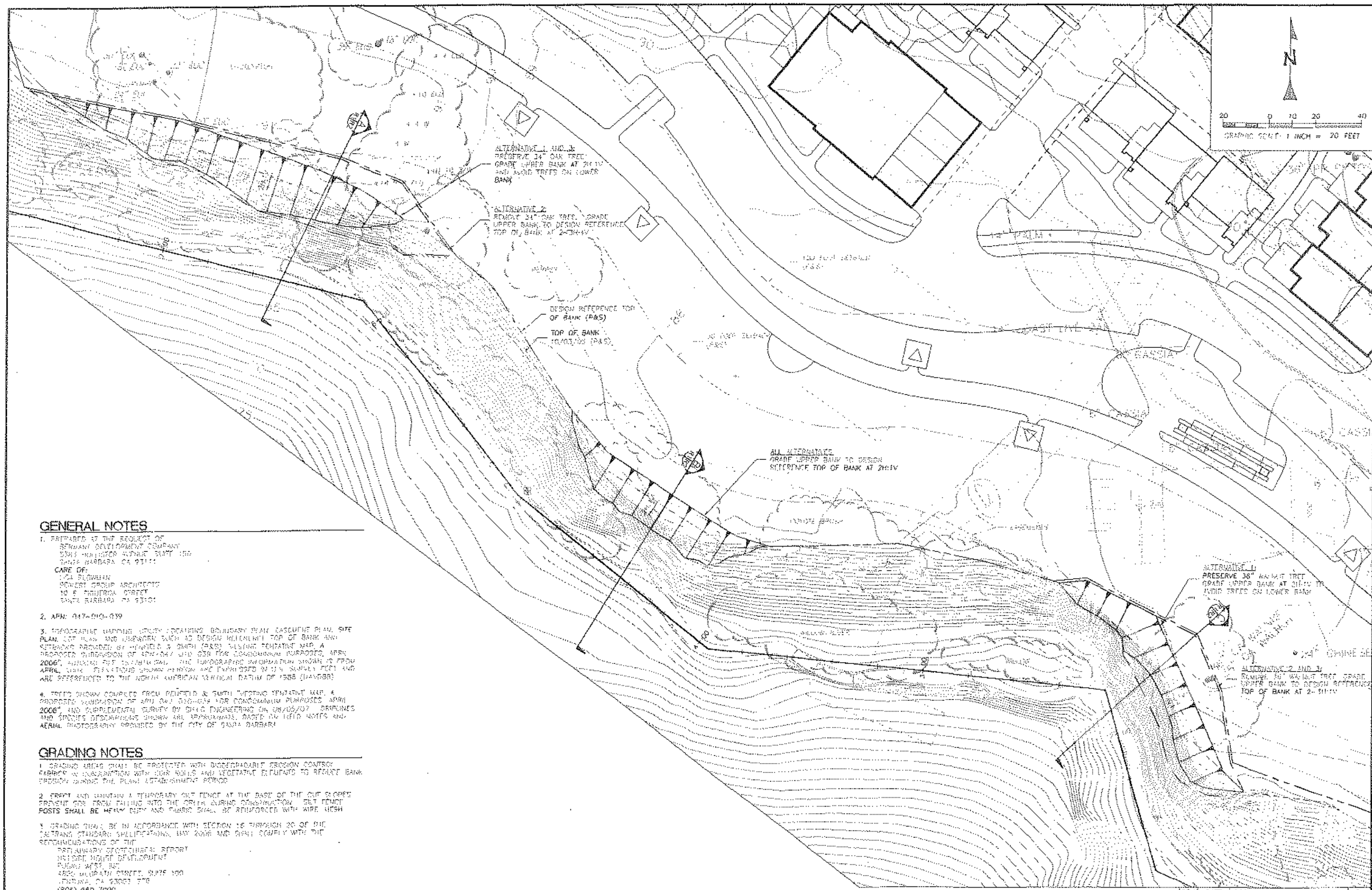
Questa Engineering Corporation. 2005. Draft Existing Conditions Study of the Arroyo Burro, Mission, Sycamore, and Laguna Creek Watersheds. Prepared for City of Santa Barbara Creeks Restoration/Water Quality Improvement Division.

Personal Communication

Meade, Daniel. Ph.D. Althouse & Meade, Inc. Telephone conversation on November 5, 2007.

ARROYO BURRO CREEK
CONCEPTUAL ENHANCEMENT PLAN

ATTACHMENT A



GENERAL NOTES

1. PREPARED AT THE REQUEST OF
   BERMANT DEVELOPMENT COMPANY
   5383 HOLLISTER AVENUE, SUITE 150
   SANTA BARBARA, CA 93111
   CARE OF:
   [illegible]
   [illegible] GROUP ARCHITECTS
   10 E. FIGUEROA STREET
   SANTA BARBARA, CA 93101

2. APN: 047-010-039

3. TOPOGRAPHIC MAPPING, UTILITY LOCATIONS, BOUNDARY PLAN, EASEMENT PLAN, SITE PLAN, LOT PLAN, AND LINEWORK SUCH AS DESIGN REFERENCE TOP OF BANK AND SETBACKS PROVIDED BY PENFIELD & SMITH (P&S) "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN 047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", [illegible]. THE TOPOGRAPHIC INFORMATION SHOWN IS FROM APRIL, [illegible]. ELEVATIONS SHOWN HEREON ARE EXPRESSED IN U.S. SURVEY FEET AND ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

4. TREES SHOWN COMPILED FROM PENFIELD & SMITH "VESTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN 047-010-039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AND SUPPLEMENTAL SURVEY BY SH+G ENGINEERING ON 08/03/07. DRIPLINES AND SPECIES DESIGNATIONS SHOWN ARE APPROXIMATE, BASED ON FIELD NOTES AND AERIAL PHOTOGRAPHY PROVIDED BY THE CITY OF SANTA BARBARA.

GRADING NOTES

1. GRADING AREAS SHALL BE PROTECTED WITH BIODEGRADABLE EROSION CONTROL FABRICS IN CONJUNCTION WITH COIR ROLLS AND VEGETATIVE ELEMENTS TO REDUCE BANK EROSION DURING THE PLANT ESTABLISHMENT PERIOD.

2. ERECT AND MAINTAIN A TEMPORARY SILT FENCE AT THE BASE OF THE CUT SLOPES TO PREVENT SOIL FROM FALLING INTO THE CREEK DURING CONSTRUCTION. SILT FENCE POSTS SHALL BE HEAVY DUTY AND FABRIC SHALL BE REINFORCED WITH WIRE MESH.

3. GRADING SHALL BE IN ACCORDANCE WITH SECTION 16 THROUGH 20 OF THE CALTRANS STANDARD SPECIFICATIONS, MAY 2006 AND SHALL COMPLY WITH THE RECOMMENDATIONS OF THE
   PRELIMINARY GEOTECHNICAL REPORT
   HILLSIDE HOUSE DEVELOPMENT
   FUGRO WEST, INC.
   4820 McGRATH STREET, SUITE 100
   VENTURA, CA 93003-7778
   (805) 650-7000

4. PLACE TREE PROTECTION AROUND TRUNK AND AVOID DISTURBANCE AND ACCESS WITHIN THE DRIPLINE OF THE 34" DBH OAK TREE TO BE PRESERVED.

CONCEPTUAL GRADING PLAN
SCALE: 1"=20'

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CONCEPTUAL GRADING PLAN

HILLSIDE HOUSE
ARROYO BURRO CREEK
ASSESSMENT
CONCEPTUAL ENHANCEMENT PLAN

DESIGNED BY:	R.T.C.
DRAWN BY:	R.T.C.
CHECKED BY:	K.F.
DATE:	11/08/07
JOB NO.:	06-538

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1 OF 3

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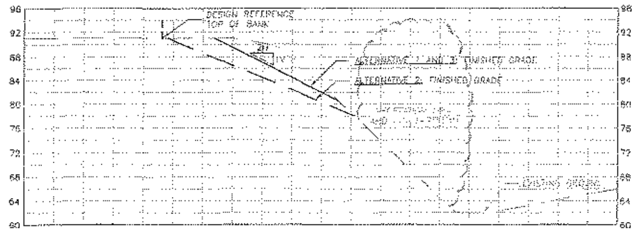

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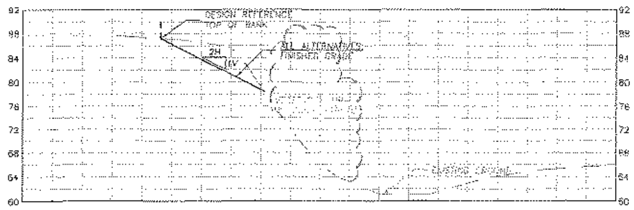

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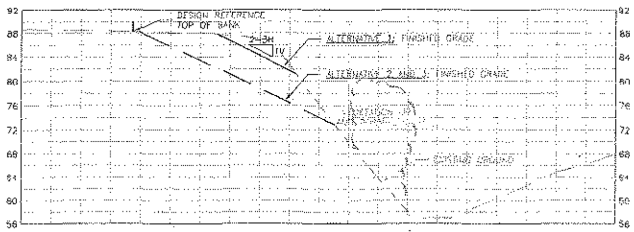

CROSS SECTION (C / R1R2)
SCALE: 1"=10'

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CROSS SECTIONS

HILLSIDE HOUSE
ARROYO BURRO CREEK ASSESSMENT
CONCEPTUAL ENHANCEMENT PLAN

DESIGNED BY: R.T.C.
DRAWN BY: R.T.C.
CHECKED BY: K.F.
DATE: 11/06/07
JOB NO.: 06-538

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R2

2 OF 3

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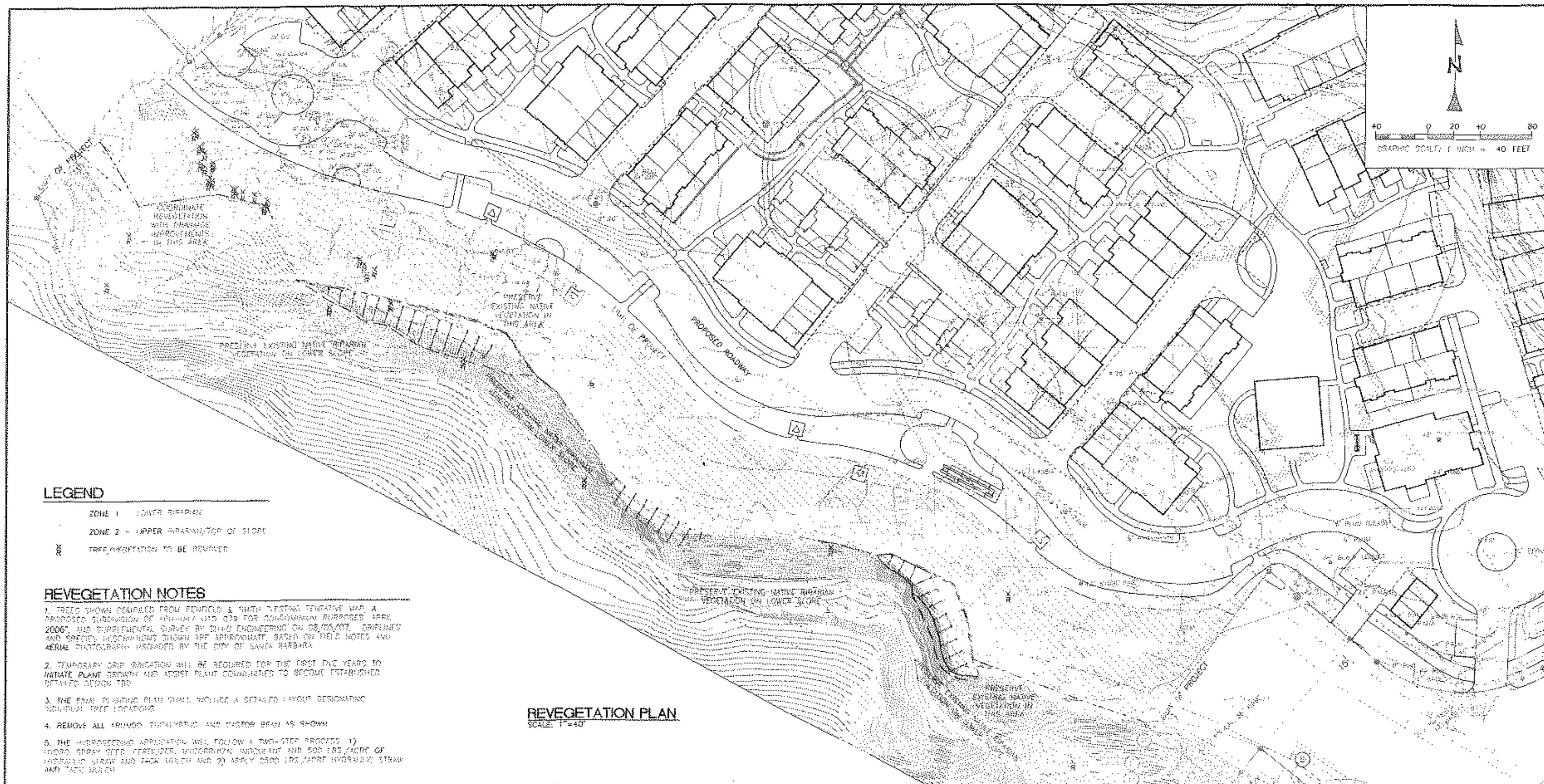

LEGEND

ZONE 1 – LOWER RIPARIAN

ZONE 2 – UPPER RIPARIAN/TOP OF SLOPE

TREE/VEGETATION TO BE REMOVED

REVEGETATION NOTES

1. TREES SHOWN COMPILED FROM PENFIELD & SMITH "EXISTING TENTATIVE MAP, A PROPOSED SUBDIVISION OF APN [illegible] 039 FOR CONDOMINIUM PURPOSES, APRIL 2006", AND SUPPLEMENTAL SURVEY BY SH+G ENGINEERING ON 08/05/07. DRIPLINES AND SPECIES DESCRIPTIONS SHOWN ARE APPROXIMATE, BASED ON FIELD NOTES AND AERIAL PHOTOGRAPHY PROVIDED BY THE CITY OF SANTA BARBARA.

2. TEMPORARY DRIP IRRIGATION WILL BE REQUIRED FOR THE FIRST FIVE YEARS TO INITIATE PLANT GROWTH AND ASSIST PLANT COMMUNITIES TO BECOME ESTABLISHED. DETAILED DESIGN TBD.

3. THE FINAL PLANTING PLAN SHALL INCLUDE A DETAILED LAYOUT DESIGNATING INDIVIDUAL TREE LOCATIONS.

4. REMOVE ALL ARUNDO, EUCALYPTUS, AND CASTOR BEAN AS SHOWN.

5. THE HYDROSEEDING APPLICATION WILL FOLLOW A TWO-STEP PROCESS: 1) HYDRO SPRAY SEED, FERTILIZER, MYCORRHIZAL INOCULANT AND 500 LBS./ACRE OF HYDRAULIC STRAW AND TACK MULCH AND 2) APPLY 2500 LBS./ACRE HYDRAULIC STRAW AND TACK MULCH.

REVEGETATION PLAN

SCALE: 1"=40'

PLANT LISTS

Zone	Botanical name	Common Name	Propogation Method	Size	Spacing	Growth Form
1-Lower Riparian	Populus balsamifera ssp. trichocarpa	black cottonwood	Container	5 Gal	Average 12 ft O.C.	tree
	Alnus rhombifolia	alder	Container	1 Gal	Average 8 ft O.C.	tree
	Baccharis salicifolia	mule fat	Container	1 Gal		shrub
	Salix spp.	willow species	Cuttings	4 ft length 0.75 to 3 inch diameter	Average 5 ft O.C.	tree/shrub
	Leymus triticoides	creeping wildrye	Container	Tree Band	Average 5 ft O.C.	grass
2-Upper Riparian/Top of Slope	Juglans californica	black walnut	Container	5 Gal	Average 12 ft O.C.	tree
	Platanus racemosa	sycamore	Container	5 Gal		tree
	Sambucus mexicana	blue elderberry	Container	5 Gal		tree/shrub
	Quercus agrifolia	coast live oak	Container	5 Gal		tree
	Eriogonum fasciculatum	California buckwheat	Container	1 Gal	Average 5 ft O.C.	shrub
	Heteromeles arbutifolia	toyon	Container	1 Gal		shrub
	Lonicera hispidula	hairy honeysuckle	Container	1 Gal		shrub
	Mimulus aurantiacus	monkey flower	Container	1 Gal		shrub
	Myrica californica	California wax myrtle	Container	1 Gal		shrub
	Rhamnus californica	coffeeberry	Container	1 Gal		shrub
	Salvia mellifera	black sage	Container	1 Gal		shrub

SEED MIX

Zone	Botanical name	Common Name	Propogation Method	lbs/acre	Growth Form
1 Lower Riparian	Achillea millefolium	yarrow	Broadcast seed	2	forb
	Artemisia douglasiana	mugwort	Broadcast seed	4	forb
	Collinsia heterophylla	Chinese houses	Broadcast seed	2	forb
	Elymus glaucus	blue wildrye	Broadcast seed	8	grass
	Hordeum brachyantherum	California barley	Broadcast seed	8	grass
	Lasthenia glabrata	goldfields	Broadcast seed	2	forb
	Leymus triticoides	creeping wild rye	Broadcast seed	8	grass
	Mimulus guttatus	seep monkeyflower	Broadcast seed	2	forb
	Trifolium obtusiflorum	creek clover	Broadcast seed	2	forb
	Vulpia microstachys	vulpia	Broadcast seed	8	grass
2-Upper Riparian/Top of Slope	Artemisia douglasiana	mugwort	Broadcast seed	4	forb
	Elymus glaucus	blue wildrye	Broadcast seed	8	grass
	Eschscholzia californica	California poppy	Broadcast seed	2	forb
	Lotus scoparius	deerweed	Broadcast seed	4	forb
	Lupinus succulentus	arroyo lupine	Broadcast seed	2	forb
	Nassella pulchra	purple needle grass	Broadcast seed	8	grass
	Scrophularia californica	bee balm	Broadcast seed	2	forb
	Sisyrinchium bellum	blue eyed grass	Broadcast seed	2	forb
	Vulpia microstachys	vulpia	Broadcast seed	8	grass

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SANTA BARBARA, CA

REVEGETATION PLAN

HILLSIDE HOUSE
ARROYO BURRO CREEK ASSESSMENT
CONCEPTUAL ENHANCEMENT PLAN

DESIGNED BY: K.F.
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3 OF 3

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